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Full Title:

Qualitative Behaviour Assessment of dogs in the shelter and home environment and relationship with quantitative behaviour assessment and physiological responses.

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Abstract

Qualitative Behaviour Assessment (QBA) was utilised to examine the behavioural expression of dogs in different housing environments and the results were compared to measurements of quantitative behaviour and physiology. Firstly, quantitative behavioural and physiological differences were investigated between dogs in 3 housing environments (short-term shelter confinement, ≤ 4 days, n = 10; long-term shelter confinement, > 30 days, n = 9; and domestic living situations, n = 10). Each dog's behaviour was recorded over a 4 h period using an ethogram consisting of 21 behaviour categories. Dogs in both short (SD) and long (LD) term confinement displayed higher frequencies of paw-lifting ($P < 0.001$), displacement behaviour (digging and/or drinking $P < 0.01$), vocalisation ($P < 0.05$) and locomotory activity ($P < 0.001$) compared to dogs maintained as family pets (PD). Salivary cortisol concentrations did not differ amongst groups ($H = 0.55$, $P = 0.76$). Secondly, quantitative behaviour and QBA were combined to investigate differences among these same 29 dogs when filmed for 1 min in both their Home Environment and a standardised Novel Environment. QBA of these video clips was made by 10 observers utilising Free-Choice-Profiling methodology. Generalised Procrustes Analysis was used to calculate a consensus profile and three main dimensions of dog expression in both Environments. The observers repeated dog scores on these dimensions with high accuracy ($P < 0.001$). Observers perceived dogs as more 'relaxed/content' in the Home Environment ($H = 17.86$, $P < 0.0001$), and more 'calm/relaxed' in the Novel Environment ($H = 13.58$, $P < 0.001$), than SD and LD dogs. In the Novel Environment, LD dogs were perceived as more 'inquisitive/curious' ($H = 5.97$, $P < 0.05$), and SD dogs as more 'curious/cautious' ($H = 6.82$, $P < 0.05$), than the other groups. Quantitative assessment of the 1 min Home and Novel Environment video clips were analysed using Principle Component Analysis (PCA), generating two main factors explaining 88% and 76% of the variation respectively. PCA factor 1 ('rest') and QBA Dimension 1 ('relaxed/content') correlated ($P < 0.0001$) in the Home Environment'. In the Novel Environment PCA factor 1 ('stand', 'sniff') correlated with QBA Dimension 1 ('clam/relaxed') and PCA factor 2 ('sniff', 'walk') correlated with QBA Dimension 2

(‘curious/inquisitive’). There was no correlation between QBA dimensions and cortisol concentrations. In sum, these results indicate that a combined quantitative/qualitative assessment facilitates the interpretation of behavioural variances resulting from housing differences and supports utilising QBA for the assessment of dog behavioural expression.

Keywords: *Behavioural Expression; Canis familiaris; Dog; Saliva Cortisol; Qualitative Behavioural Assessment; Shelter.*

1. Introduction

The aim of shelters is to rehome animals and in doing so optimise their long term welfare (Titulaer et al., 2013), yet the shelter environment itself has been shown to be inherently stressful (Wells, 2004, Ronney et al., 2007 and Bowman et al., 2015). Upon entry individual dogs are exposed to a number of stressors including; isolation in a novel environment (e.g. Beerda et al., 1999), separation from social attachment figures (e.g. Tuber et al., 1996), exposure to excessive noise levels (e.g. Sales et al., 1997 and Bowman et al., 2015), changes in routine and introduction to an unpredictable environment (e.g. Tuber et al., 1999). Numerous authors have reported that exposure to these stressors, both short and long term, leads to compromised welfare (Beerda et al., 2000, Hennessy et al., 2002, Stephen and Ledger, 2006, Taylor et al., 2007).

Studies investigating the compromise to dog welfare, during their stay in shelters, have utilised behavioural and physiological measures of stress (e.g. Hennessy et al., 2001, Barrera et al., 2010 and Bergamasco et al., 2010). More recently cognitive measures of emotional valence and qualitative assessment of emotional experience have been used to assess the impact of shelter stressors; including conspecific separation (Walker et al., 2014), short vs long term shelter housing (Titulaer et al., 2013), and the assessment of individual Quality of Life (QoL) (Kiddie and Collins, 2014 and Kiddie and Collins, 2015).

Quantitative measurement of behaviour indicative of stress in the kennel environment is time consuming and its interpretation tends to rely on extensive post-hoc analysis (Stephen and Ledger, 2006; Rooney et al., 2007 and Haverbeke et al., 2008). Emphasis is usually on individual behaviour that occurs most frequently or for longer durations, and the value of infrequent behaviour, that potentially indicates stress, can be lost in statistical analysis (e.g. circling, lip-licking or paw lifting [Rooney et al., 2009]). The behavioural repertoire of dogs is diverse, and the variability of individual response patterns is reinforced by the extreme morphological variation seen within this species, and by individuals' age, sex and past experience. All these factors can make it difficult to interpret observed shifts in behaviour in relation to stress, and can give rise to studies reporting apparently inconsistent or contradictory results. Unsurprisingly, there has been little consensus on which behaviour may be indicative of poor, or good, welfare in dogs (Hiby et al., 2006) with recent research evidencing the complicated nature of repetitive behaviour in kennelled dogs (Denham et al., 2014).

HPA activity is a well utilised method for the assessment of a dog's physiological response to the shelter environment (for a review see Hennessy, 2013). HPA activity has traditionally been measured through plasma cortisol (e.g. Hennessy et al., 1997, Beerda et al., 1998 and Hennessy et al., 1998), and more recently, urine cortisol:creatinine ratios (C/Cr) (e.g. Hiby et al., 2006; Stephen and Ledger, 2006 and Rooney et al., 2007). The analysis of salivary cortisol has also become an increasing popular non-invasive alternative to plasma analysis in the assessment of canine stress (e.g. Coppola et al., 2006, Horváth et al., 2007, Bergamasco et al., 2010 and Bowman et al., 2015). Cortisol, however, is produced in response to all sustained arousal, not only that produced by stress (Hiby et al., 2006 and Belpedio, 2010), and therefore cortisol measurement must be considered alongside other ways of assessing shelter stressors.

Qualitative assessment approaches have been engaged to evaluate general Quality of Life (QoL) in dogs (e.g. Hewson et al., 2007, Taylor and Mills, 2007 and Timmins et al., 2007). Recently this approach has been utilised to specifically assess the QoL of dogs in shelters (Kiddie and Collins, 2014 and Kiddie and Collins, 2015). Kiddie and Collins (2014 and 2015) employed a questionnaire developed for use by shelter staff who act as proxies for dogs, which are unable to speak for themselves. However, such studies are limited by their reliance on the judgments of people who know the dog subjects well, such as their owners or trainers.

An alternative methodology that might provide a more subjective tool in the qualitative assessment of a dog's experience in a shelter environment is Qualitative Behaviour Assessment (QBA). QBA is based on human descriptors that summarise the dynamic, expressive style of an animal's interaction with its environment e.g. 'confident', 'anxious' or 'apathetic', and was originally developed and validated for pigs (Wemelsfelder et al., 2001, Wemelsfelder et al., 2009 and Wemelsfelder et al., 2012). QBA has since been applied to a range of animals including dairy cattle, horses, dairy buffalo, sheep, and dogs (e.g. Rousing and Wemelsfelder, 2006, Napolitano et al., 2008, Walker et al., 2010, Cockram et al., 2012 and Napolitano et al., 2012). Walker et al. (2010) showed that observers unacquainted with dog subjects could coherently and consistently assess these dogs' emotional expressions from brief video clips. Additionally, QBA has been documented to show significant and meaningful correlations with physiological indices of stress in a range of species including; pigs, cattle and sheep (Stockman et al., 2011, Rutherford et al., 2012, Wickham et al., 2012 and Stockman et al., 2013).

The present study investigates the applicability of utilising QBA within the shelter environment by exploring whether and how QBA can be combined with quantitative behavioural and physiological indicators to investigate the effect of lengths of shelter stay on dogs.

2. Materials and methods

Procedures were approved by The University of Auckland Animal Ethics Committee (ethics approval number R585).

2.1 Study animals

Twenty nine dogs were used in this study (three entire females, 14 de-sexed females, six entire males and six de-sexed males). Of these, nine dogs were housed in long term (LD) confinement ($\geq$ 30 days in an animal shelter), 10 dogs were housed in short term (SD) confinement (≤ 4 days in an animal shelter), and 10 pet dogs (PD) had lived in their owners' homes for a minimum of 12 months prior to the commencement of the study. Recently researchers have been increasingly utilising companion dogs to provide base line results when assessing the effects of the shelter environment (Beerda et al., 1999, Hennessey et al., 1997, Steiss et al., 2007 and Viggiano et al., 2009). In this study our PD group acted as a control. The LD and SD dogs were sourced from two animal shelters (Shelter A n = 4 [LD], n = 2 [SD]; Shelter B n = 5 [LD], n = 8 [SD]), located within Auckland, New Zealand. The average length of confinement for a LD was 140 ± 119 days and 3.4 ± 0.8 days for a SD dog. The age of dogs in SD and LD could only be approximated by shelter staff, therefore dogs were categorised into three groups: juvenile (< 18 months; n = 5), adult (> 18 months < 8 years; n = 21) and senior (> 8 years; n = 3). Four of the dogs were purebred (Alaskan Malamute n = 1; Labrador n = 1; Poodle n = 1; Samoyed n = 1) and the remainder crossbreed.

2.2 Daily husbandry

Dogs at Shelter A were individually kept in concrete-floored kennels consisting of two sections: an indoor section (2.5 m × 1.5 m; length x width), containing a wooden bed, and an outdoor section (3.5 m × 1.5 m; length x width). The outside section of the kennel was comprised of wire allowing dogs to see other dogs in neighbouring kennels. The two sections were connected by wooden doors that could be closed overnight. A water bowl was provided in the kennel and feeding took place twice a day at approximately 10:00 h and 14:00 h. The dogs were confined to the indoor section of their kennel from 18:00 h to 07:00 h. Each dog was moved to a larger outdoor concrete run for 30 min per day so that their kennel could be cleaned (between 08:00 h and 10:00 h). Dogs could not socially interact.

Dogs at Shelter B were individually kept in concrete-floored kennels (3 m × 1.5 m; length × width) with a wooden bed raised off the ground at the far end of the kennel. Each kennel had solid sides preventing dogs from visualising other dogs in the shelter. The dogs were individually let out into a grass exercise area twice daily for 30 min at a time; once in the morning during cleaning (between 08:00 h and 10:00 h), and once in the afternoon after feeding (between 13:00 h and 15:00 h). The dogs were fed once a day at approximately 12:00 h. In both shelters staff did not interact with dogs other than transporting them to the exercise areas.

The pet dogs were housed in family homes and had various routines depending on the owners' work schedule. Four of the 10 PD dogs were taken to work on a daily basis with their owners. The remaining 6 PD dogs were left at home for between 6 - 8 h per day inside the house.

2.3 Video recording

2.3.1 Home environment (HE) recordings

The behaviour of each LD dog was videoed for 1 h continuously over four consecutive days at 10:00 h. For each LD dog, recording occurred between 1 - 11 months after admission to the shelter dependent on the length of time each dog had been resident when the study began (1 month n = 3 dogs; 3 months n = 2 dogs; 4 months n = 1 dogs; 8 months n = 1 dog; 10 months n = 1 dog). After completing the videoing of the LD group it emerged that the same sampling method could not be used for the SD group given the high risk of the dogs in this group being re-homed within the 4 day period. It was therefore decided that video footage for both SD and PD dogs would be collected for 4 h continuously on a single day from 10:00 - 12:00 h and 1500 -17:00 h. SD recording occurred between 2 - 4 days after admission to the shelter dependent on the arrival date of each dog at the start of the study (2 days n = 3; 3 days n = 2; 4 days n = 5). The PD subjects were filmed in the location where the PD dog's bed was located and where the dog was normally left when the owner was out.

For each dog this location varied i.e. bedroom (n = 3), garage (n = 2), lounge (n = 1), or, if dogs were regularly taken to work with their owner, an office space (n = 4). All dogs were filmed using a Sony DV21E 'Handy Cam' (Sony New Zealand, Auckland, New Zealand) placed on a tripod opposite the kennel or in the corner of the room where the dog was left when the owner was out. In total 4 h of video footage was collected for each dog in the study. At Shelter A, AM recording began directly after feeding and 0 - 2 h after exercise (LD and SD). PM recording began 1 h after both feeding and exercise (SD). At Shelter B, AM recording began 0 - 2 h after exercise and 2 h prior to feeding (LD and SD). PM recording began 3 h after both feeding and exercise (SD). AM recording of PD dogs began a minimum of 2 h after feeding and exercise, whilst PM recording began a minimum of 7 h after feeding and exercise.

For the purposes of QBA analysis (see section 2.6: Qualitative Behavioural Assessment), a 1 min video clip was isolated from the total 4 h recorded for each dog in the HE. In order to standardise the selection of this clip, extraction occurred at exactly 150 min into the total recording time. It was thought that after this time dogs would have habituated to the presence of the camera regardless of whether recording took place in 1 h bouts or a continuous 4 h session.

2.3.2 Novel Environment (NE) recordings

Additionally, for the purposes of QBA analysis pertaining to a novel environment (see section 2.6: Qualitative Behavioural Assessment), each dog was placed in a purpose-made aluminium portable test pen (9 m^2) 1 day subsequent to the completion of HE recording. Each side of the test pen comprised seven slatted horizontal aluminium bars, fitted inside an aluminium frame. The test pen was set up outdoors in a location unfamiliar to the dogs. For the SD and LD dogs this was a grass area located at the back of both animal shelters that the dogs had not previously been, and for the PD left at home it was on a neighbouring property, for those dogs taken to work it was on a nearby football field. The behaviour of each dog in this NE was video-recorded for 1 min. Each dog was removed from his/her kennel, office or home by the researcher and walked on-lead < 500 m to the location of the test pen and placed inside. Recording commenced immediately after the researcher had placed the dog into the test pen and had walked out of view of the dog. No other people were present during the NE recording. This recording resulted in 29 NE clips. Thus a total of 58 video clips were collected for QBA: 29 HE and 29 NE clips.

2.4 Saliva cortisol sampling

Saliva samples were taken from each dog at the end of filming the HE (sample collection took place at 11:30 h for LD and 17:30 h for both SD and PD). A saliva sample was taken from the dog's cheek pouches with a cotton salivette (Salivette Systems, Sarsted Australia Pty LD, Mawson Lakes, South Australia). Samples were collected in duplicate to ensure an adequate amount of saliva was obtained for each dog. The cotton salivettes were infused with citric acid, which stimulates saliva flow, and were rotated in the dogs' cheek pouch for 1 min. Each cotton salivette was replaced in its tube and put on ice. The cotton salivettes were centrifuged within 4 h of collection at 4000rpm for 10 min and cooled down to a temperature of -20^{0}C. The samples were analysed by Gribbles Veterinary Pathology located in Hamilton (New Zealand).

2.5 Quantitative scores of behaviour

The video recordings were used to continuously record the behaviour of the dogs for 4 h, using Observer XT software (Noldus Information Technology, V7, 2007, Wageningen, the Netherlands). The dogs' behaviour was categorised on the basis of an ethogram with 26 distinct behaviour categories (Table 1). Using the same equipment and categorisation, the dogs' behaviour was also recorded in the 29 HE and 29 NE video clips of 1 min length. Any behaviour occurring less than three times were excluded from analysis. Behaviour analysis and data transformation can be found in Table 1.

2.6 Qualitative Behavioural Assessment (QBA)

2.6.1 Observers

Ten female observers, recruited through email advertisements sent to undergraduate students, provided qualitative assessments of the dogs' behaviour. All observers had previous experience interacting with dogs; five worked with dogs on a daily basis and had previous experience observing dogs, whilst the remaining five were students studying animal behaviour. None of the observers had previous experience with Qualitative Behaviour Assessment (QBA) or Free Choice Profiling (FCP) methodology.

2.6.2 Experimental procedures

To generate data a FCP methodology was used as described in Wemelsfelder et al. (2001), and for dogs in Walker et al. (2010). In summary, FCP asks the observers to generate their own descriptive vocabulary based on direct observations of the animals, and thus facilitates the active interpretation by observers of these animals' expressions, rather than providing them with pre-selected descriptive terms (Walker et al., 2010). Our 10 observers were instructed in FCP procedures in session 1 (term generation). During this session the observers generated their own descriptive vocabularies by watching the 58 dog clips and by writing down adverbs after each clip that in their view described the dog's emotional expression. The observers were shown 29 HE followed by 29 NE clips in a randomised order on a 17' computer monitor (MacBook Pro, Apple, Cupertino CA, USA). A refreshment break was provided between HE and NE clips. In session 2 (quantification), observers were provided with a compilation of their personal terms generated in session one, each term set next to a visual analogue scale (0 - 125 mm). The observers then watched the same videos shown in session 1, HE clips before the break and NE clips after the break, but shown in a different randomised order to session 1. After each clip, observers scored the dog shown in that clip on each of their personal terms, by marking the visual analogue scale at a point deemed appropriate. Session 3 (quantification 2), took place one day after session 2, and was aimed at testing the intra-observer reliability of observer assessments. It was a replication of session 2, except that the video clips were shown in a different randomised order to session 1 and session 2.

By the end of session 3, the 10 observers had used their personal rating scales to produce four sets of scores (two for HE and two for NE) for all 29 dogs. For each observer, the two HE score sets were entered into one data matrix defined by the number of dogs (2 × 29) and the number of terms used by the individual observer, and the same was done for the two NE score sets. Thus a total of 10 × 2 = 20 individual observer data matrices were created.

2.7 Statistical analysis

2.7.1 Quantitative scores of behaviour

Analysis of ethogram-based data was carried out using Minitab (version 15) for Windows (Minitab Pty Ltd, Sydney NSW, Australia). For each of the 21 behaviour categories a one-way ANOVA, followed by a post-hoc Tukey test, was used to identify differences between the three treatment groups. Due to repeated testing of some data, Bonferroni adjustments were applied with an alpha level of $P < 0.0025$. Categorical data were investigated using Goodness of Fit Chi Squared test, to investigate behavioural differences amongst the three groups, compared to a null hypothesis that behaviour occurred with equal frequency across the three groups.

The distribution of dogs within both the LD and SD group was unbalanced across the two animal shelters. General Linear Model was used to investigate whether shelter location had a significant effect on behaviour.

Differences in cortisol concentrations between the three housing conditions were tested using the Kruskall-Wallis H test. Spearman’s Rank Correlation Coefficient was used to investigate correlations between saliva cortisol levels and the performance of individual behaviour. Non-parametric statistics were employed as the residuals did not follow normal distribution (assessed using Anderson-Darling) when we attempted to fit parametric models, even when data were transformed.

2.7.2 Qualitative behavioural assessment

In the first instance, to investigate intra-observer reliability (see section 2.6.2), the combined HE and NE data matrices from session 2 and 3 were analysed using GPA (Genstat 2008, VSN International, Hemel Hempstead, Hertfordshire, UK, Wemelsfelder et al., 2000). Secondly, the HE and NE data matrices from session 2 were analysed separately using GPA and these results were used to compare treatments. To briefly summarise, GPA detected the level of consensus between observer scoring patterns on the basis of inter-sample distances specified by each observer. The calculation is essentially a process of complex pattern recognition and takes places independently of the meaning of the terminologies used by the observers. How well each individual observer's scores fitted the consensus profile was quantified by the Procrustes statistic and expressed as an 'observer plot' (Wemelsfelder et al., 2000). The statistical significance of this consensus was then evaluated against a mean randomised profile, obtained by re-running GPA with randomised observer data sets a hundred times. A one-tailed student t-test (n = 100) was used to determine whether the consensus differed significantly from the mean randomised profile.

2.7.3 Interpreting the GPA dimensions

The consensus profile can have as many dimensions as the largest number of terms generated by any of the 10 observers. To allow interpretation, this number was reduced through PCA to three main consensus dimensions explaining the majority of variation between the observed dogs. These main consensus dimensions were then correlated to the original observer data matrices producing two-dimensional interpretive word-charts, one for each of the 10 observers. All the terms of a particular observer were correlated with the principle axes of the consensus profile and the higher the correlation of the term the more weight it had as a descriptor of that axis. Semantic consistency seen between observer charts made it possible to select representative labels to interpret the main consensus dimensions. GPA produced a quantitative score for each dog on each QBA dimension, represented graphically on the consensus sample plots. This score was used to evaluate the differences between individual dogs and subsequently in combination with ethogram-based quantitative behaviour data (see section 3.5.2).

2.7.4 The Relationship between qualitative and quantitative measures of dog behaviour

To investigate the relationship between QBA assessments of the dogs' behaviour and ethogram-based quantitative behavioural analysis, in both the HE and NE, we employed a form of 'data mapping' described in Minero et al. (2009). First, Principal Component Analysis (PCA; covariance matrix, no rotation) was performed on the ethogram-based quantitative behaviour data. This resulted in the attribution of scores to individual dogs on the two main factors of this PCA. These PCA factors were subsequently used as the frame onto which both ethogram-based quantitative behaviour data and QBA assessments of individual dogs were mapped. To achieve this Spearman Rank Correlation Coefficient was used to correlate the original ethogram-based quantitative behaviour score for each behavioural category to the individual qualitative dog score, on each QBA dimension, produced during the GPA process. The r-values resulting from these correlations served as the coordinates to which each behavioural category and GPA dimension was mapped onto the PCA factors in a two-dimensional plot.

Treatment effects along the first two factors of the ethogram-based quantitative behaviour PCA were analysed using one-way ANOVA for the NE and Kruskall Wallis for the HE environment.

3. Results

3.1 Quantitative scores of behaviour

Of the 21 behavioural categories analysed over a 4 h period, 12 of the 21 showed significant treatment differences. Differences were found for 'walk', 'stand', 'rest', 'sit', and 'lip-lick' behaviour (Table 2). Pet dogs spent more time resting and showed lower levels of active behaviour (walking, standing and sitting) than SD and LD dogs. Pet dogs also lip-licked less than dogs in the other two treatments.

Treatment differences were found in the performance of rare behaviour, with the occurrence of ‘paw-lift’, ‘drink’, bark’, ‘whine’, ‘tail-wag’, and ‘pant’, lower for PD than for SD and LD dogs. The performance of ‘sniff’ was lower, whilst ‘dig’ was higher, for SD dogs compared with PD and LD dogs (Table 2).

3.2 Kennel environments

Minimal difference was found between the dogs housed at the two different animal shelters for any of the 21 behaviour recorded. This suggests that housing and husbandry routine had little or no effect on the presence and duration of the observed behavioural categories.

3.3 Salivary cortisol

Out of the 29 saliva samples obtained, only 18 of the samples contained a sufficient quantity for analysis (PD n = 6; SD n = 7; LD n = 5). There was no significant difference in the mean cortisol levels between the three groups of dogs (H = 0.550, df = 2, P = 0.760). There were no significant correlations between the performance of individual behaviour over the 4 h period and cortisol concentrations.

3.4 Qualitative behaviour assessment

3.4.1 Observer consensus

The consensus profiles for the HE and NE assessments both explained a significantly higher percentage of the variation between the observer matrices than the mean of 100 randomised profiles (Table 3). This indicates that the variation explained by these consensus profiles is not an artefact of the statistical GPA procedures.

3.4.2 Intra-observer reliability

The scores attributed by observers to individual dogs in the two repeat studies of HE and NE assessments were correlated highly significantly across all three consensus dimensions of these assessments ($0.78 < r < 0.97$, all $P < 0.001$), indicating that observers had repeated their qualitative assessment of individual dogs with considerable accuracy. Given this high level of repeatability, only data from session 2 will be presented in the following results. For more detailed discussion of QBA quantitative dog scores see 3.4.4.

3.4.3 Dimensions of dog behavioural expression

Dimension 1 of the HE assessment explained 68.8%, dimension 2 11.2%, and dimension 3 5.4% of the variation between dogs, giving a total of 85.4% of the variation explained. Dimension 1 of the NE assessment explained 46.1%, dimension 2 18%, and dimension 3 11.8%, of the variation between dogs, giving a total of 75.9% of the variation explained.

Fig. 2 shows, as an example, both HE and NE word charts pertaining to one observer. These word charts display all the terms utilised by that observer to describe the dogs' behavioural expression in both the HE and NE treatments and visually illustrates (highest and lowest loading variables on each axis) the observer's terms that best correlate with the three main consensus dimensions of these assessments; i.e. this observer described HE dimension one as ranging from 'relaxed/sleepy' to 'stressed/anxious', and NE dimension one as 'calm/relaxed' - 'anxious/stressed'. HE dimension two was described as 'interested/alert' to 'lethargic/depressed', and NE dimension two as 'curious/active' - 'confused/calm'. HE dimension three was described as 'calm/watchful' - 'frustrated/bored' and NE dimension three as 'hyperactive/ anxious – curious/cautious'.

To provide an overview of all observers' terms, Table 4 lists the terms (two for each observer) that correlated most strongly with each of the three consensus dimensions of the HE and NE assessments. This table shows that a considerable number of observers used the same terms to describe the different dimensions. For example, in the NE assessment all 10 observers used the term 'calm' in their top two descriptors for the positive end of dimension 1. Where observers used different terms, the meanings of these terms tended to be either similar in mood/tone (e.g. 'stressed/anxious/agitated/frustrated' and ‘curious/inquisitive/investigative’) or complement each other in mood/tone (e.g. ‘confident/alert’, ‘awkward/worried’). In some cases, terms on the second or third dimension appear to contradict each other in tone (e.g. ‘alert’, ‘calm’); as the percentage of variation explained by a dimension lowers (e.g. dimension 3), the more likely it becomes that high-loading terms lack consistency of meaning. On the basis of this table, we labelled HE dimension 1 as ‘relaxed/content – stressed/anxious’, dimension 2 as ‘confident/excited – depressed/bored’, and dimension 3 as ‘alert/attentive – agitated/frustrated’. For the NE assessment we labelled dimension 1 as ‘calm/relaxed – excited/anxious’, dimension 2 as ‘curious/inquisitive – confused/unsure’, and dimension 3 as ‘confident/agitated – ‘cautious/curious’. These labels will be used throughout the remainder of the paper.

3.4.4 Qualitative behavioural analysis treatment effects

A significant effect of treatment on observer attribution of scores to dogs (QBA quantitative dog scores) was found for HE dimension 1 (H = 17.86, P < 0.0001). Post-hoc analysis showed the PD group to appear significantly more ‘relaxed/content’ than the other two groups (Fig. 3). In the NE assessment a treatment effect was observed across all three dimensions (dimension 1: H = 13.58, df = 2, P < 0.001; dimension 2: H = 5.97, df = 2, P < 0.05; dimension 3: H = 6.82, df = 2, P < 0.05). Post-hoc analysis showed that on dimension 1 the PD group appeared more ‘calm/relaxed’ than the other groups; that on dimension 2 the LD group appeared more ‘inquisitive/curious’ than the other groups, and on dimension 3 the SD group appeared more ‘cautious/curious’, than other groups (Fig. 3).

3.5 The Relationship between qualitative and quantitative measures of dog behaviour

3.5.1 Quantitative analysis of dog behaviour in the QBA video clips

PCA of the ethogram-based behaviour data showed two main factors explaining 61.8% and 26.4% of the variation in the HE assessment, and 40.8% and 35% of the variation in the NE assessment. Table 5 shows the loadings of ethogram behavioural categories on to these factors. Thus for the HE assessment, PCA factor 1 was represented at the negative end by 'rest', and at the positive end by 'vocal', 'stand' and 'walk' (Table 5). There was a significant effect of treatment on this factor (H = 9.35, df = 2, P < 0.01). Post-hoc analysis revealed that seven out of 10 dogs in the PD group loaded highly negatively on PCA factor 1, reflecting a greater incidence of resting in this group than in other groups. PCA factor 2 was characterised by 'vocal' at the negative end and 'stand', 'walk' and 'jump' at the positive end, however there was no significant effect of treatments in the factor 2 scores.

For the NE assessment, high loading variables on the first PCA factor (explaining 40.8% of the variation) were 'vocal' on the negative end, and 'stand' and 'sniff' on the positive end (Table 5). There was no effect of treatment on PCA factor 1. Factor 2 (explaining 35% of the variation) was characterised by 'stand', 'walk' and 'sniff' on the negative end and 'pant' on the positive end. There was a significant effect of treatment on PCA factor 2 (H = 11.01, df = 2, P < 0.005). Post-hoc analysis revealed that dogs in the PD group clustered at the negative end of the axis suggesting that PD dogs were standing, walking and sniffing more and panting less during the NE assessment than SD and LD dogs.

3.5.2 Correlation between quantitative and qualitative behaviour assessments

HE QBA dimension 1 ('relaxed/content – stressed/anxious') correlated positively with 'rest' (r = 0.47, P < 0.01) and negatively with 'stand' (r = -0.71, P < 0.0001), 'walk' (r = -0.71, P < 0.0001), 'jump' (r = -0.69, P < 0.0001), 'vocal' (r = -0.77, P < 0.0001), 'pant' (r = -0.38, P < 0.05), 'dig' (r = -0.47, P < 0.01) and 'lip lick' (r = -0.58, P < 0.001). No significant correlations were found between HE QBA dimension 2 ('confident/excited – depressed/bored') and behaviour. HE QBA dimension 3 correlated negatively with 'walk' (r = -0.37, P < 0.05), 'jump' (r = -0.56, P < 0.005) and 'vocal' (r = -0.359, P < 0.05).

Fig. 4 presents a visual representation of the association between ethogram-based quantitative behaviour scores and QBA qualitative dog scores, when positioned in reference to the axes generated by PCA analysis of quantitative behavioural variables (see section 2.7.4). HE QBA dimension 1 (‘relaxed/content-stressed/anxious’) was significantly correlated with PCA factor 1 (r = -0.791, P < 0.0001), indicating that dogs engaging in resting behaviour were assessed as relaxed/content while dogs engaging in vocalising, walking and standing behaviour were characterised by observers as ‘stressed/anxious’. The correlations of HE QBA dimension 2 with PCA factor 1 and PCA factor 2 were not significant (r = 0.165; ns and r = 0.148; ns, respectively), nor were the correlations of HE QBA dimension 3 with PCA factor 1 or PCA factor 2 (r = -0.27; ns and r = -0.085; ns, respectively). No significant correlations were found between the QBA dimensions and cortisol concentrations or between individual behaviour categories and cortisol concentrations in the HE environment.

NE QBA dimension 1 (‘calm-relaxed – excited/stressed’) correlated negatively with ‘walk’ (r = -0.44, P < 0.05), ‘run’ (r = -0.55, P < 0.005), ‘jump’ (r = -0.43, P < 0.005) and ‘vocal’ (r = -0.59, P < 0.001). NE QBA dimension 2 (‘curious/inquisitive–confused/unsure’) was positively correlated with ‘stand’ (r = 0.44, P < 0.05) and ‘urinate’ (r = 0.59, P < 0.001) and negatively with ‘pant’ (r = -0.39, P < 0.05). NE QBA dimension 3 was negatively correlated with ‘stand’ (r = -0.39, P < 0.05), ‘walk’ (r = -0.41, P < 0.05) and ‘paw lift’ (r = -0.48, P < 0.01).

NE QBA dimension 1 was significantly correlated with PCA factor 1 (r = 0.371, P < 0.05) indicating that dogs engaging in standing and sniffing behaviour were assessed as ‘calm/relaxed’. NE QBA dimension 2 correlated with PCA factor 2 (r = -0.374, P < 0.05) indicating that dogs engaging in sniffing, walking and standing behaviour were perceived as curious/inquisitive. NE QBA 3 significantly correlated with PCA factor 2 (r = 0.360, P = 0.055) indicating that dogs performing panting and lip-licking were perceived as confident/agitated. No significant correlations were found between the QBA dimensions and cortisol concentrations or between individual behaviour categories and cortisol concentrations in the NE environment.

4. Discussion

We compared Qualitative Behavioural Assessment (QBA) to quantitative assessment of behaviour and physiology of dogs in three types of housing (short-term shelter confinement (SD), long-term shelter confinement (LD) and domestic living situations (PD)). Both quantitative behaviour assessment and QBA revealed significant differences among the three groups. Combining these measures through correlation and multivariate analysis produced significant results validating the usefulness of QBA as a tool for monitoring behaviour in shelter-housed dogs.

Our findings demonstrate that the shelter-housed and pet dogs differed in the behaviour they displayed over the four hours of observation. Shelter-housed dogs showed longer average durations of active behaviour, and higher frequencies of tail-wagging, paw-lifting, panting, barking, whining and drinking than the pet dogs, whilst pet dogs rested for longer periods of time. This marked difference supports the suggestion by other authors that the behaviour of pet dogs can provide a baseline against which that of dogs in other housing conditions can be compared (e.g. Hennessey et al., 1997, Beerda et al., 2000 and Viggiano et al., 2009). Additionally, the increased behavioural arousal observed in the shelter-dogs suggests that these individuals may have experienced increased stress comparative to the pet dogs in the study (Hiby et al., 2006). Although behaviour predominately differed between shelter-housed dogs and pet dogs, 3 out of 21 behaviour categories were additionally observed to differ between the SD and LD groups. The SD group displayed increased standing and digging behaviour and decreased sniffing behaviour comparative to the LD group, which might reflect the on-going adjustment of the SD group to the shelter environment.

The salivary cortisol concentrations among the three groups of dogs did not differ significantly. There are a number of possible explanations for our non-significant cortisol findings. Firstly, only 18 (out of a total of 29) of the samples contained sufficient saliva for analysis meaning each treatment group had less than (or equal to) seven individuals possibly contributing to reduced statistical viability. Also, Hennessy et al. (2001) suggests that after the first three days in a shelter environment, plasma cortisol levels tend to decrease as dogs become habituated to their environment. Since six of the seven samples collected from our SD group and all of the samples from the LD group were obtained from dogs that had already been in the shelter for 4 (or more) days, it is possible that cortisol levels had already decreased. Furthermore, Rooney et al. (2007) suggest that dogs that have previously been habituated to a kennel environment may experience a less dramatic increase in cortisol levels, unfortunately information pertaining to previous detainments was unobtainable for the dogs in our study. It is also well known that prolonged stressors (such as long term kennelling) resulting in high levels of glucocorticoid can exert inhibitory effects on the central and pituitary level of the HPA axis. This can result in increasing resilience and a reduction in the level of cortisol response (Beerda et al., 1998 and Hennessy et al., 2001). It is also worth considering the possibility of individual breed as an influencing factor, however 86% of our sample population were crossbreed dogs. Finally, the time of day when sampling occurred varied between the three groups. The collection of saliva samples took place at varying times of day likely contributing to increased variability between individuals (Hennessy, 2013). Taken as a whole, these various factors may help to explain the variation in cortisol levels between individuals and the lack of significance observed between groups.

Our observer group showed significant agreement in their assessments of dog expression, and identified three main consensus dimensions in both HE (QBA dimension 1: ‘relaxed/content-stressed/anxious’; QBA dimension 2: ‘confident/excited-depressed/bored; and QBA dimension 3: ‘alert/attentive-agitated frustrated’) and NE (QBA dimension 1: ‘calm/relaxed-excited/anxious’; QBA dimension 2: ‘ curious/inquisitive-confused/unsure’; and QBA dimension 3: ‘ confident/agitated-cautious/curious’) environments. The qualitative dimensions for dog behavioural expression that we describe in this study are comparable to ones we described in a previous study, e.g. ‘playful/happy/confident’ to ‘nervous/unsure/tense’ and ‘alert/inquisitive/investigative’ to ‘attention-seeking/quiet/unsure’(Walker et al., 2010) suggesting that qualitative dimensions of dog behavioural expression are relatively stable across differing observers, environments and dogs. Recent QBA research has looked at the use of engaging a standardised list of QBA terms, rather than allowing observers to generate their own term list, ultimately saving time and the number of observation sessions required (e.g. Andreasen et al., 2013 and Phythian et al., 2013). A standardised list of QBA terms could potentially provide a mechanism for allowing QBA methodology to be a useful and practical tool in the daily monitoring of behaviour in kennelled dogs, preferably in combination with a selection of specific quantitative indicators (see for example Kessler and Turner (1997), for cats, and Wiseman-Orr et al. (2011), for pigs). The comparability of the terms generated to describe dog behavioural expression in the present study and in our previous work (see Walker et al., 2010) suggest that a standardised list of terms could be robust and feasible. Future research could develop such lists, test their inter- and intra-observer reliability, and cross-validate their relevance to welfare with accepted indicators for dog health and well-being.

Our QBA results combined meaningfully with our quantitative behavioural analysis. The PD group loaded alongside ‘rest’ in the HE and alongside ‘stand’, ‘walk’ and ‘sniff’ in the NE. Thus for the PD group, both inactivity (resting) and explorative behaviour (walking/standing/sniffing) were perceived by observers to reflect content/calm/relaxed dogs. The LD group loaded alongside QBA variables ‘curious/inquisitive’ in the NE, which correlated with quantitative variables ‘walk’, ‘stand’ and ‘sniff’, indicating that the LD group behaved in an explorative manner in the NE, but were not perceived to be as calm and relaxed as PD dogs while doing so. The SD group loaded alongside QBA variables ‘cautious/curious’ in the NE, which correlated with ‘stand’, ‘walk’ ‘paw-lift’ and ‘sniff’. In this context the QBA descriptor ‘cautious’, combined with the presence of a traditional behavioural stress indicator (paw-lifting), may reflect a more anxious or stressed group of dogs. Thus, QBA assessments appeared to map meaningfully onto quantitative behaviour assessments, and to be helpful in interpreting these in terms of an animal's overall state. This supports the finding of previous studies that both types of measurement can complement and strengthen each other in studies of animal behaviour (e.g. Minero et al., 2009 and Rutherford et al., 2012).

Research has documented significant associations between QBA dimensions and a range of physiological measures in cattle including; core body temperature, heart rate, plasma glucose, neutrophil:lymphocyte ratios and plasma lactate concentrations measured at exsanguinations (Stockman et al., 2011 and Stockman et al., 2012). Such findings suggest that the differences in behavioural expression identified by observers in QBA studies are validated by physiological measures. In the present study no correlations were found between salivary cortisol concentrations and QBA dimensions in either the HE or NE environments. Taking into consideration the number of limitations previously discussed, other research identifying correlations between physiological measures and QBA dimensions and the meaningful relationship evidenced between QBA dimensions and quantitative measurement of behaviour in the present study, it seems plausible to suggest that the non-existent relationship between QBA dimensions and cortisol concentrations resulted from methodological difficulties. Future research is required to establish if and how physiological measures of stress in dogs correlate meaningfully to QBA dimensions.

5.0 Conclusion

Quantitative ethogram-based behavioural observations identified a significant difference between our shelter-housed and pet dogs during the observation period. Pet dogs (PD) spent more time resting and showed lower levels of active behaviour (sitting, standing and walking) in comparison to dogs in both short (SD) and long (LD)-term confinement which showed a significantly higher frequency of behaviour that is potentially indicative of stress including; paw-lifting, displacement behaviour (e.g. digging or drinking), excessive vocalisations and increased locomotory activity. These quantitative findings were complimented in the 1 min observations by QBA. QBA dimension 1 in the HE environment (relaxed/content-stressed/anxious') and all 3 QBA dimensions in the NE environment (1: calm/relaxed-excited/anxious', 2: 'curious/inquisitive-confused/unsure' and 3: 'confident/agitated-cautious/curious') correlated significantly and meaningfully with quantitative behavioural measurements, validating the QBA as a tool for behavioural evaluation in shelter-housed dogs. Both qualitative and quantitative methods were able to extract key differences among the three dog groups, suggesting that future research utilising traditional quantitative behavioural observations can be strengthened by the addition of QBA.

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Table 1

Table 1: Ethogram

Behaviour Categories	Description of Behaviour
Locomotive Behaviour	
Walk [a, *d*]	Forward movement with legs resulting in shift of whole body to new postion in enclosure. No more than one paw is off the ground at any one time.
Run [b, *d*]	As walking but faster paced where multiple paws leave the ground at the same time.
Stand [a, *d*]	All four paws on ground and legs upright and extended supporting body.
Rest[*d*]	Ventral/lateral lying on ground with all four legs resting and in contact with ground. Dog may also be curled up in a tight ball. Head is either resting on ground or held up in air. Eyes are either open or closed.
Sit [a, *d*]	Hind quarters on ground with front two legs being used for support.
Circle [b, *d*]	A circular motion is traced in one direction (or on the spot) repeatedly.
Jump[*f*]	Dog has both hind legs on the floor and rears in a manner that results in both forelegs in contact with the wall or bars of enclosure. This behaviour also includes dogs that are observed with all four legs off the ground.
Paw Lift [b,,*f*]	Front limb is raised and lowered often in quick succession.
Stretch[*d*]	Dog moves body into playbow position by extending front legs and lowering chest and head towards the ground.
Maintanence Behaviour	
Eat [b,*d*]	Dog ingests food provided by kennel attendent.
Drink [b,*d*]	Dog drinks from automated water system or bowl provided.
Urinate[*f*]	Dog excretes urine.
Defecate[*f*]	Dog excretes faecal material.
Vocal Behaviour	
Bark [b,,*f*, #]	Mouth opens and then quickly closes in a snapping motion and a low frequency voclaisation is produced. Each bark is a short duration often performed in succession.
Howl [b,,*f*, #]	Continuous medium pitched vocalisation which the subject performs with muzzle pointed skywards.
Whine [b,,*f*, #]	Soft, high pitched, whistling vocalisation that occurs in short repeated bursts.
Yelp[*f*] [b,,*f*]	Loud (relative to whine) high pitched vocalisation of short duration.
Oral Behaviour	
Lip Lick [a, *f*]	Part of the tongue is shown and moved along the upper lip.
Yawn [b, *f*]	Mouth open wide for a period of a few seconds whilst exhaling.
Pant [b, *d*]	Mouth open with tongue extended accompanied with rapid breathing and expansion/contraction of chest.
Sniff [b, *d*]	Air inhaled forcibly through the nose.
Bite Kennel Wire[*d*]	Dog bites wire of kennel enclosure.
Other	
Groom [a, *d*]	Behaviours directed towards the subjects own body including licking, self-biting and scratching.
Dig [*b, d*]	The dog uses forepaws to repeatedly scratch the surface of the walls and floor.
Tail Wag [b, *d*]	Repetitive movement of the tail in a side to side motion.
Shake[*f*]	Rapid vibration of the whole body.

[a] = data normalised by square root transformation
[b] = data transformed to 0/1 categorical data
[d]= behaviour recorded continuously (duration behaviour)
[f]= behaviour recorded as single events (frequency behaviours)
[#] = behaviour combined into one category 'vocal' for analysis
[*] = behaviour excluded from analysis due to infrequency of occurrence (observed on < 3 occasions)

Table 2

Table 2: Behavioural differences between housing treatment groups based on 4 h observations in the home environment. SD = Short-term confinement dogs, LD= Long-term confinement dogs, PD = Pet dogs.
Significance: *** p<0.001; ** p<0.01; * p<0.05. Statistics are based on SQRT transformed data, or categorical transformation (0/1). Numbers shown under each treatment group are mean duration (± SD) [#] or total count [*] of behaviour performed during the 4 h observation. [#] Treatments on the same row that do not share a letter are significantly different from one another at p<0.05 (Tukey HSD post-hoc tests).

Behaviour	Housing Treatment			F-Ratio
	SD (n=10)	LD (n=9)	PD (n=10)	
Rest (seconds)[#]	8992 ± 1551^{a}	8440 ± 1887^{a}	12513 ± 2836^{b}	10.12***
Sit (seconds)[#]	1498 ± 772^{cd}	2908 ± 2169^{c}	1424 ± 2502^{d}	3.41*
Stand (seconds)[#]	3044 ± 1140^{e}	1803 ± 1610^{f}	325 ± 296^{g}	25.32***
Walk (seconds)[#]	854 ± 817^{h}	1085 ± 916^{h}	750 ± 139^{i}	9.82***
Lip Lick (count)[#]	27.5 ± 14.5^{j}	54.4 ± 32.4^{j}	6.1 ± 5.9^{k}	18.5***
				Pearson Chi-Sq (χ^2 value)
Drink (0/1)[*]	1	10	6	13.64**
Sniff (0/1)[*]	9	4	9	10.98**
Bark (0/1)[*]	2	9	7	11.8**
Whine (0/1)[*]	1	9	8	17.6*
Tail Wag (0/1)[*]	2	10	9	20.99***
Paw Lift (0/1)[*]	1	8	8	15.03***
Dig (0/1)[*]	2	8	4	7.3**

Table 3

Table 3: Consensus Parameters for HE and NE assessments. * indicates $P < 0.0001$

	HE assessment (Procrustes Statistic ± SD)	**NE assessment** (Procrustes Statistic ± SD)
Consensus profile	73.70	55.06
Mean randomised profile	30.00± 0.13	31.4± 0.19
t_{99}	120.00*	54.01*

Table 4

Table 4. Terms (two for each of the 10 observers) that showed the highest positive and negative correlations with dimensions 1, 2 and 3 of the consensus profile for HE and NE assessments. The number in parentheses after some terms refer to the number of observers using that term, otherwise only one observer used that term.

	HE assessment		**NE assessment**	
Consensus Dimension	**Positive end**	**Negative end**	**Positive end**	**Negative end**
1	Relaxed (6), Comfortable (3), Content (3), Sleepy (2), Calm (2), Quiet, Motionless, Tired, Laid Back.	Stressed (5), Anxious (4), Agitated (2), Frustrated (2), Alert, Bothered, Bored, Worried, Distracted, Aroused, Tense	Calm (10), Relaxed (7), Content, Quiet, Bored	Excited (4), Anxious (3), Stressed (3), Agitated (2), Aroused, Frustrated, Upset, Restless, Active, Stimulated, Tense, Desperate.
2	Confident (3), Stimulated (3), Excited (3), Interested (2), Curious (2), Inquisitive (2), Motivated, Alert, Observant, Nervous, Frightened.	Depressed (5), Bored (3), Resigned (2), Worried, Upset, Sad, Fearful, Indifferent, Lethargic, Lonely, Calm, Withdrawn, Tired.	Curious (5), Inquisitive (3), Active (3), Investigative (2), Stimulated (2), Dominant, Focused, Excited, Interactive, Content.	Confused (4), Unsure (2), Worried, Anxious, Awkward, Lonely, Fearful, Attentive, Calm, Nervous, Patient, Bored, Tense, Watchful, Attention-seeking, Alert.
3	Alert (4), Calm (3), Attentive (3), Resigned (2), Bored (2), Quiet, Submissive, Interested, Lazy, Watchful, Inquisitive.	Agitated (5), Frustrated (3), Sleepy (2), Confident (2), Stimulated, Excited, Lively, On-Edge, Bored, Bothered, Tense, Aggressive.	Confident (6), Agitated (2), Hyperactive (2), Restless, Excited, Aroused, Anxious, Alert, Aggressive, Attention-seeking, Happy, Dominant, Distracted.	Nervous (2), Wary (2), Curious (2), Inquisitive (2), Unsure (2), Worried, Focused, Alert, Submissive, Careful, Cautious, Nosy, Timid, Investigative, Scared.

Table 5

Table 5. Principle component analysis (PCA) of quantitative behavioural data from 1 minute video clips taken in home (HE) and novel (NE) environments. The highest loading behaviours for each factor is shown in **bold**. Behaviours are left blank because they did not occur in that environment.

	HE Assessment			NE Assessment		
	Eigen Value	% of Variance Explained	Cumulative Variance Explained	Eigen Value	% of Variance Explained	Cumulative Variance Explained
PCA 1	13.876	61.8	61.8	14.43	40.8	40.8
PCA 2	5.929	26.4	88.3	12.38	35.0	75.7

Behaviour	HE PCA 1	HE PCA 2	NE PCA 1	NE PCA 2
Rest	**-0.064**	-0.095		
Sit	0.021	-0.006	0.004	0.028
Stand	**0.301**	**0.586**	**0.124**	**-0.65**
Walk	**0.293**	**0.504**	-0.056	**-0.655**
Run	0.003	0.025	-0.063	-0.126
Jump	0.126	**0.402**	-0.091	-0.056
Circle			-0.049	-0.001
Vocal	**0.884**	**-0.44**	**-0.969**	-0.069
Pant	0.033	0.156	-0.039	**0.101**
Drink	0.01	0.063		
Urinate			0.027	-0.034
Defecate			0.005	0.01
Groom	-0.003	0.006		
Dig	0.048	0.035	0.007	0.001
Sniff	0.031	0.005	**0.129**	**-0.294**
Tail Wag	0.098	-0.019	-0.093	-0.097
Paw Lift	0.012	0.016	0.02	-0.12
Stretch	-0.005	-0.001		
Bite Kennel Wire	0.008	0.051		
Shake			0.002	0.004
Lip Lick	0.085	0.051	0.009	0.052

Figure Captions:

Fig 1. Observer Plots. Axes reflect GPA scaling values for relative observer distance. Numbers represent individual observers. The dotted ellipse represents the 95% confidence region for what may be considered the normal population of observers.

Fig 2. Word Charts for observer 5. Axes reflect the level at which observer terms correlate to the three main dimensions of the consensus profile.

Fig 3. Dog score plots. Axes reflect the three main dimensions of the consensus profile for HE and NE assessments.

Figure 1

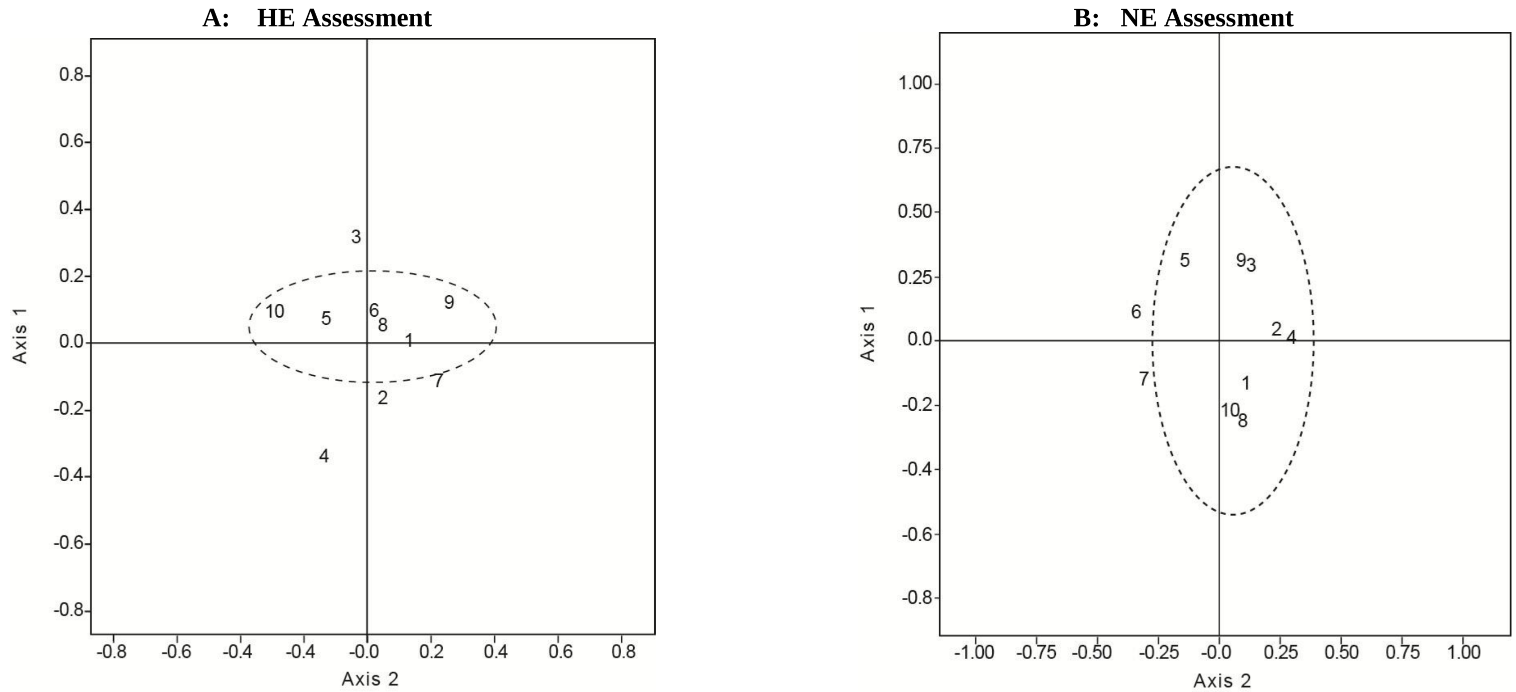

A: HE Assessment
Axis 1
Axis 2
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.8
-0.8 -0.6 -0.4 -0.4 -0.0 0.2 0.4 0.6 0.8
1 2 3 4 5 6 7 8 9 10
B: NE Assessment
Axis 1
Axis 2
1.00
0.75
0.50
0.25
0.0
-0.2
-0.4
-0.6
-0.8
-1.00 -0.75 -0.50 -0.25 -0.0 0.25 0.50 0.75 1.00
1 2 3 4 5 6 7 8 9 10

Figure 2

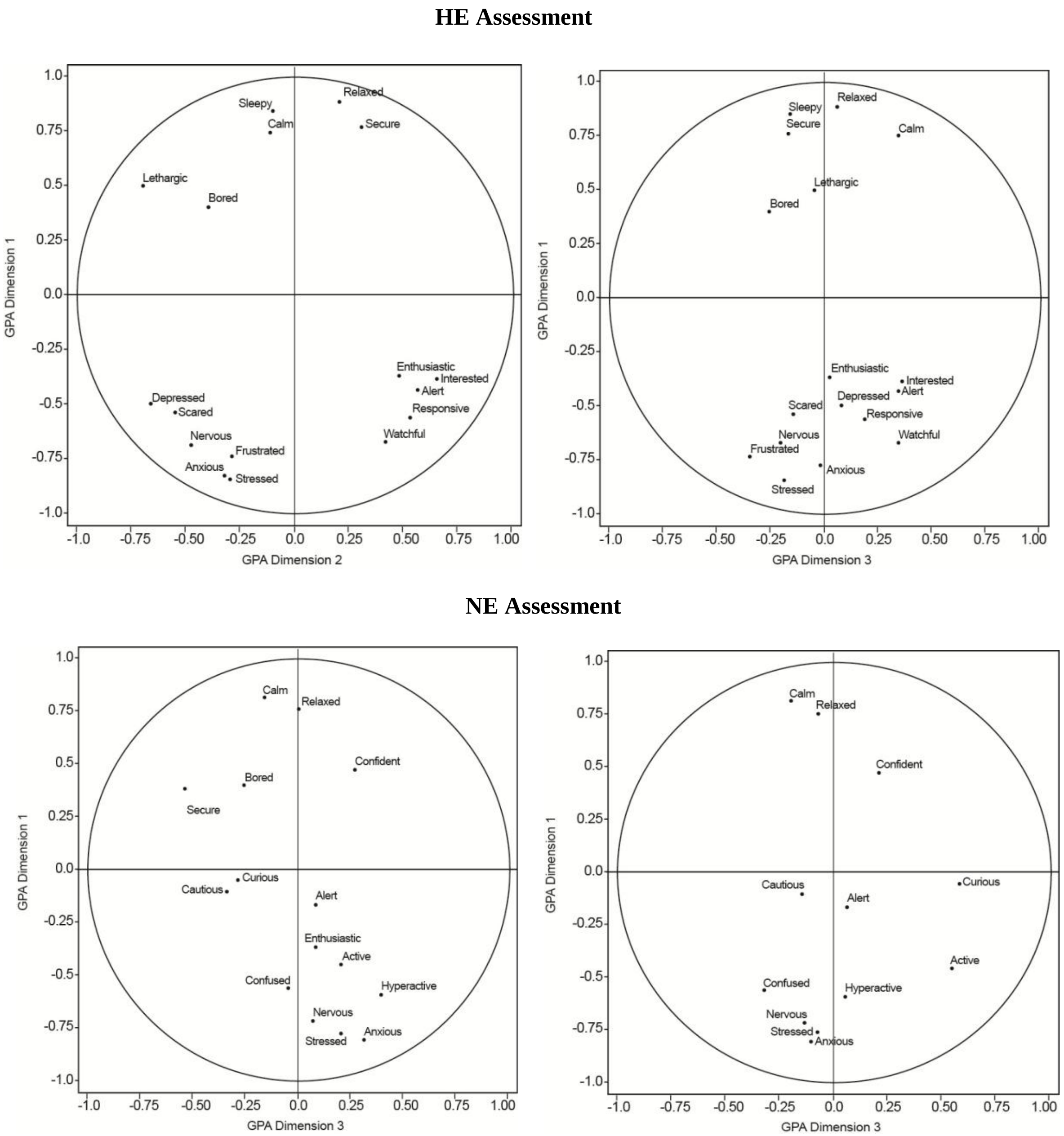
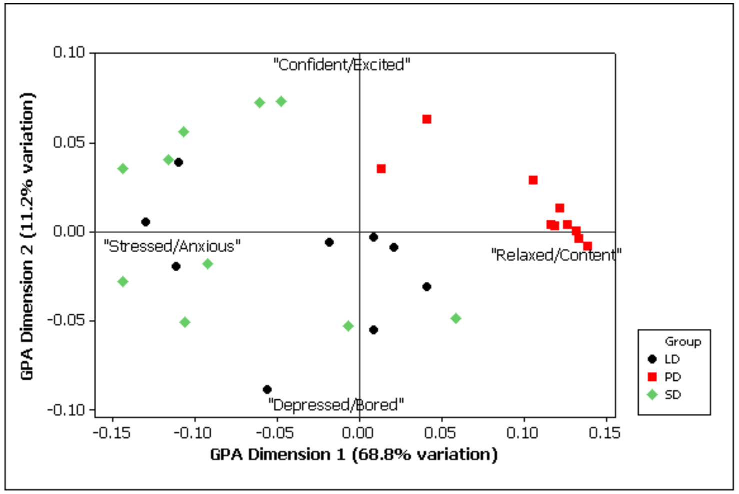
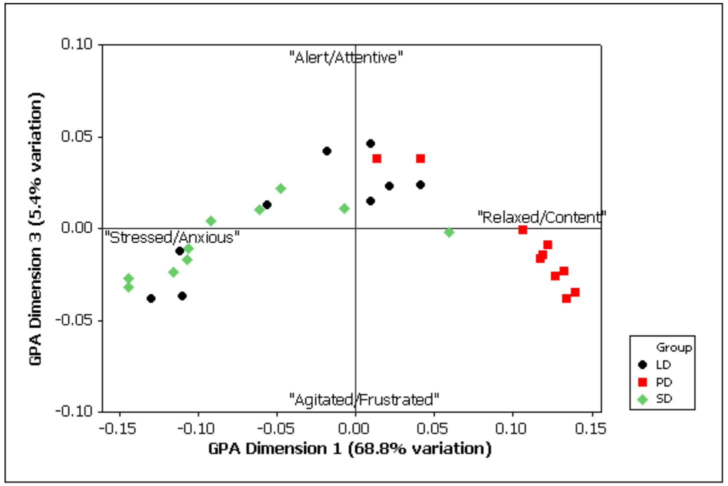

HE Assessment
GPA Dimension 1
GPA Dimension 2
GPA Dimension 3
Relaxed
Sleepy
Calm
Secure
Lethargic
Bored
Enthusiastic
Interested
Alert
Responsive
Watchful
Depressed
Scared
Nervous
Frustrated
Anxious
Stressed
NE Assessment
Confident
Curious
Cautious
Active
Hyperactive
Confused

Figure 3

HE Assessments

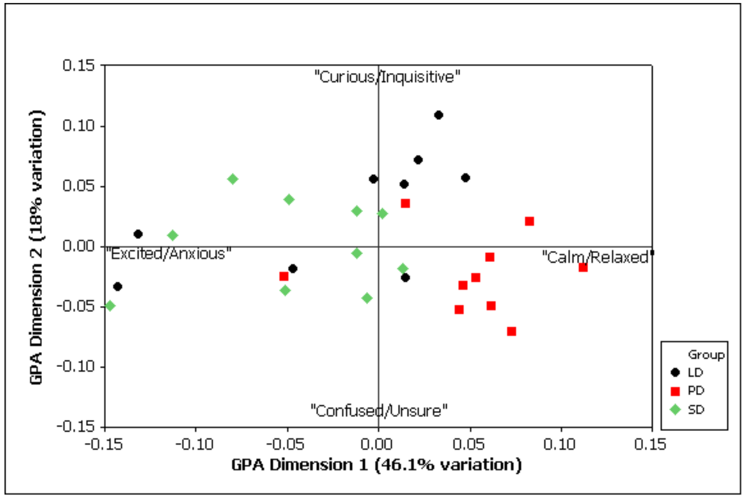


3a:

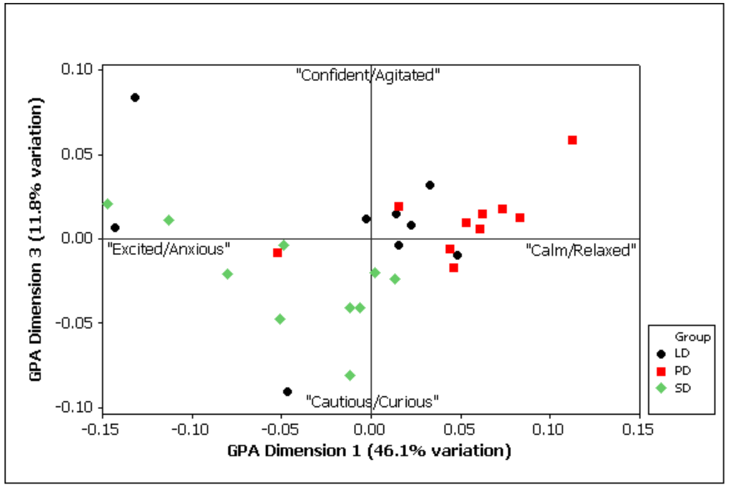


3b:

NE Assessments



3c:



3d: